ANNUAL RESEARCH PROGRESS REPORT
Report of Progress (AD-421)

Accession: 0149542 Year: 98 Project Number: 1265-32000-051-00 D
Mode Code: 1265-15-00 STP Codes: 3.2.2.1 100%
NATL PROG(S) 103 Animal Health 100%

Title: BIOSYSTEMATACS OF HELMINTH PARASITES OF RUMINANTS AND CURATION OF U.S. NATIONAL PARASITE COLLECTION

Period Covered From: 01/98 To: 12/98

Progress and Outcomes:

1. What major problem or issue is being resolved and how are you resolving it?

Parasitic worms of large food animals cause production losses to farmers resulting in higher prices to consumers. Losses are in the form of slower weight gain, death of young animals, higher feed costs, costs of drugs to remove parasites, and loss of use of contaminated pastures. These losses cost U.S. producers between 1 and 2 billion dollars annually. Scientific research aimed at reducing these losses to parasitic worms is hampered by difficulties in identifying and classifying the species of parasites causing the losses, especially the forms of the parasites that are found in the environment or in the waste products of the host. Our research provides basic information on the structural and molecular characteristics useful for determining the species causing the losses and constructing classifications to predict the appropriate control measures for new or emerging pathogens. The information is used by scientists to evaluate biological or chemical control agents, determine the importance of reservoir hosts such as wildlife, or develop specific diagnostic tools. We also provide a reference collection of specimens of parasites of animals to support similar research nationwide.

2. How serious is the problem? Why does it matter?

Improving methods for diagnosing and reducing economic losses to these parasitic worms depend on the accurate identification of the parasite species. Many of the identifications can be made only on the basis of careful microscopic comparisons of adult parasites collected after the death of the host. The development of diagnostic tools useful for eggs

and immature stages in the environment or in the waste products of the host are needed to target appropriate biological or drug treatments. This will reduce the cost of treatment and minimize the impact of control agents on the environment. Predictive classifications of related parasites provide information useful for recognizing and controlling imported or emerging pathogens that threaten farm animals or contaminate our food or water.

3. How does it relate to the National Program(s) and National Program Component(s) to which it has been assigned?

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National Program 103, Animal Health (100%)
This research involves 3 Program Components: 1) Preventing the introduction of Exotic or Foreign Animal Diseases through the movement of domesticated animals and wildlife; 2) Identifying and predicting the impact of Emerging Animal Diseases, and 3) Zoonotic Diseases.

4. What was your most significant accomplishment this past year?

Accomplishment: Discovery of a cryptic species complex of abomasal nematodes in North American ruminants. Impact: This discovery and description of a new species of medium stomach worm, of the genus Teladorsagia, clearly indicates that we do not yet have a basic understanding of the species diversity of nematode pathogens in domestic and wild ruminants in North America. The new species was recognized on the basis of DNA sequence differences. Previously, the long-spicule forms of medium stomach worms in domestic and wild ruminants were believed to belong to a single species. This work is critical to understanding the interface between agricultural and natural ecosystems, the exchange of pathogenic nematodes between domestic and wild ruminants, and the potential for emerging disease related to these parasites within the context of global change. Outcome: This information provides the basis for improved diagnostics that may permit determination of the source of infective agents and allow for more effective disease control programs on farms with the potential for the interaction of domestic and wild ruminants.

5. Describe your major accomplishments over the life of the project, including their predicted or actual impact

Accomplishment: ARS scientist, in collaboration with scientists in Scotland, Australia, and Ukraine, improved microscopic and DNA probe diagnostics for nematode pathogens of horses. Impact: The improved diagnostics will provide essential working tools for the identification of the species responsible for an emerging disease (larval cyathostomiasis), the development and testing of new antiparasitic

drugs required by widespread nematode resistance to current antiparasitic drugs, and the testing of biological agents needed to control the more than 50 species of nematode pathogens of horses. Outcome: The improved control agents will greatly improve the health, well being and productivity of horses worldwide used for farming, recreation and in many countries for food.
Accomplishment: New understanding of phylogeny, biological/ life history patterns, and transmission dynamics for protostrongylid lungworms (in collaboration with University of Saskatchewan and University of Guelph, Canada). Impact: Protostrongylid nematodes cause

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significant disease in domestic and wild sheep, and farmed deer in North America. Outbreaks of disease depend in part on variations in local climate conditions that affect the density of snail populations, which serve as intermediate hosts for the protostrongylid nematodes. Phylogenetic studies provide a predictive framework for understanding host-parasite biology, and the patterns of exchange of parasites among domestic hosts and between domestic and wild hosts. Life history and transmission studies determine factors imposed by the environment that limit the distribution of these nematodes, and allow prediction of the impact of global climate change on distribution and the propensity to cause disease. Outcome: Improved capability to predict and manage the impact of protostrongylids in wild ruminants that serve as primary food resources for northern communities and in domestic sheep at boreal latitudes in the US.
Accomplishment: Developed improved systematics and diagnostics for gastrointestinal nematodes in ruminants. Impact: Studies of morphology and molecular data at the species level in the genera Ostertagia, Nematodirus and others among domestic and wild ruminants are the foundation for refined diagnostics and standardization of methods for identification. The results will be used by scientists developing new chemical and biological agents or improved management practices for controlling these pathogens of cattle, sheep and deer. Outcome: Losses in weight gain, mortality of young animals, cost of drug treatment, and loss of use of contaminated pastures experienced by animal farmers will be reduced. The improved understanding of the North American fauna of nematode parasites of ruminants provides a foundation for surveillance and prevention of introductions and dissemination of exotic parasites.
Accomplishment: Provided a National reference collection of specimens of parasites of animals and the associated database of specimen records to researchers worldwide via the Internet and the loan of specimens. Impact: This web site gets 16,000 hits a month. Parasitologists in ARS, and others working in veterinary, medical, or wildlife parasitology, have access to the necessary specimens and database to conduct studies in identification, classification and distribution that impact all efforts to control parasites of agricultural or medical

importance. The unique specimens, collected over a period of 150 years, provide a storehouse of genetic information that serves as a primary resource for biodiversity research. Outcome: The efficiency and prospects for success of all research worldwide on parasites of animals are enhanced. The identification and control of parasites that contaminate fish, shellfish, or red meat and/or increase the cost of its production is more accurate and efficient, resulting in food that is safer and less expensive. Prospects are enhanced for preventing the importation of exotic parasites that threaten American agriculture. Accomplishment: With colleagues in the Parasite Biology and

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Epidemiology Laboratory, LPSI, developed method to determine both presence and intensity of infection of medium stomach worms in individual cattle. Impact: This molecular method provides the means to revolutionize the diagnosis of ostertagiasis in cattle, the most important nematode parasite of cattle worldwide. Treatment can be administered only when the intensity of the specific pathogen reaches clinical levels. Previously the part of a multi-species nematode population in a host made up of the specific pathogen could not be determined on a cost-effective basis. Outcome: Cost of diagnosis and treatment will be reduced. The effective life-span of antiparasitic drugs will be extended because parasite resistance will not develop as fast, and the environmental impact of the drug on the environment will be reduced. Most animals will not require treatment and natural immunity can be allowed to develop in the absence of treatment.

6. What do you expect to accomplish during the next year?

Develop a total evidence phylogeny of the tapeworms. A combination of molecular characters from 18S rDNA and morphology (total evidence) will be used for the first time to examine relationships among the orders of the tapeworms. This is expected to lead to a robust classification for tapeworms, and serve as the basis for studies among economically important and zoonotic groups such as the Taeniidae. Accurate phylogenys for tapeworms form the basis for understanding parasite biology, distribution and diseases.
Phylogeny for Taenia spp. will be developed. Tapeworms of the genus Taenia are among the most economically significant parasites causing substantial disease in humans (as primary parasites and as zoonoses), domesticated stock and companion animals. Phylogenetic analysis of morphological characters will be used to assess relationships among the species as the basis for new classifications and to augment control of infections in humans and domestic stock.
Develop a phylogeny of Trichinella spp. Trichinosis continues as a public health concern and the relationship among domestic and sylvatic species and their role in disease has yet to be adequately defined.

Phylogenetic studies of molecular data and cospeciation analysis will be used to develop new insights about the relationships, transmission patterns, geographic distribution and history for Trichinella in the United States and throughout the world.
Redescribe a large stomach worm of cattle, imported into Central and South America and Mexico. This nematode, Mecistocirrus, poses a threat to U.S. cattle if it is imported. The new information provided will be useful to prevent importation or to help control it if it is imported.
Organize and conduct an International Workshop on the Systematics of Nematode Parasites of Horses. The improved terminology, nomenclature

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and diagnostics that will emerge from this workshop will benefit all research aimed at controlling these pathogens of horses through biological, pharmaceutical, or animal husbandry methods.
Report and describe the first cryptic species discovered with molecular characters and redescribe other poorly described nematode parasites of horses.

7. What technologies have been transferred and to whom? When is the technology likely to become available to the end user (industry, farmer, other scientists)? What are the constraints, if known, to the adoption durability of the technology?

As Adjunct Professor, presented two invited lectures at Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, Canada.
As Visiting Professor, Veterinary School, Melbourne University, Australia collaborated with faculty and graduate students in classification of nematode parasites of horses, cattle and sheep using molecular characters.
As Visiting Professor, University of Glasgow, Scotland, contributed to development of diagnostic probes for nematode parasites of horses.
Presented invited lecture on global change and emerging diseases to Office of Polar Programs, National Science Foundation, April, 1998.
Presented invited lecture on tapeworm phylogeny at Museum of Natural History, Geneva, Switzerland, February, 1998.
Presented invited lecture on the Contributions of ARS Systematics to Veterinary Parasitology, when accepting Distinguished Veterinary Parasitologist Award from American Association of Veterinary Parasitologists, Baltimore, July, 1998.
Provided records of the U.S. National Parasite Collection on the Internet (16,600 hits on web site each month).
Loaned parasite specimens from U.S. National Parasite Collection to 493 researchers and accessioned 900 new lots of specimens; Identified 160 helminth species of medical or veterinary importance at the request of state, federal or private institutions.
Published Checklist of names of 51 nematode species of horses for use

by scientists in pharmaceutical, biological and other control research programs.
Published ARS Miscellaneous Pub. No. 1343, "Systematic Collections of the Agricultural Research Service", to assist students, scientists and others in finding reference specimens and information on animals and plants, including many pests, of agricultural importance.

8. List your most important publications and presentations, and articles written about your work (up to three total--NOTE: this does not replace your reviewed publications which are listed below)

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ZARLENGA, D., HOBERG, E.P., STRINGFELLOW, F. and LICHTENFELS, J.R. 1998. Comparison of two polymorphic species of Ostertagia and phylogenic relationships inferred from rDNA and mDNA sequences. J. Parasitol. 84:806-812.

LICHTENFELS, J.R., KHARCHENKO, V.A., KRECEK, R.C. and GIBBONS, L.M. 1998. An annotated checklist of 93 species level names for 51 recognized species of small strongyles (Nematoda: Strongyloidea: Cyathostominea) of horses, asses and zebras of the world. Vet. Parasitol. 79: 65-79.

HOBERG, E.P. (Invited Presentation) 1998. Macroparasites and muskoxen: A model for emerging pathogens and global change in the Arctic. National Science Foundation Arctic Affiliate Seminar Series, April, 1998.

PUBLICATIONS:

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ZARLENGA, D.S., ASCHENBRENNER, R.A. and LICHTENFELS, J.R. 1997. Genetic differences among populations of Trichinella ... sequence repeats. Proc. 9th Intrn'l Conf. Trichinellosis, Mexico City pp.47-52.

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LICHTENFELS, J.R., KHARCHENKO, V.A., KRECEK, R.C. and GIBBONS, L.M. 1998. Annotated checklist of names for 51 recognized species ... strongyles ... of horses, ... of the world. Vet. Parasitol. 79:75-79.

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GIBBONS, L.M. and LICHTENFELS, J.R. 1998. Cyathostomum ...: Proposed ... usage by designation of a neotype for ... species S. tetracanthus Mehlis, 1831 (Case 3075). Bull. Zoological Nomenclature. 55:1.

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ZARLENGA, D.S., HOBERG, E.P., STRINGFELLOW, F. and LICHTENFELS, J.R. 1998. Comparisons of ... species within the Ostertagiinae ... inferred from rDNA repeat and ... DNA sequences. J. Parasitol. 84:806-812.

05.
LICHTENFELS, J.R. PILITT, P.A., DVOJNOS, G.M., KHARCHENKO, V.S. and KRECEK, R.C. 1998. A redescription of C. radiatus ... parasite of the Ass, ... & horse, E. caballus. J. Helminthol. Soc. Wash. 65:56-61.

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ZARLENGA, D.S., GASBARRE, L.C., BOYD, P., LEIGHTON, E. and LICHTENFELS, J.R. 1998. Identification ... of O. ostertagi eggs ... amplification of ITS-1 sequences. Vet. Parasitol. 77:245-257.

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LICHTENFELS, J.R., KIRKBRIDE, J.H. and CHITWOOD, D.J. (Editors) 1998. Systematics collections of the ARS, ARS Misc. Pub. #1343. ARS Information, USDA, Washington, DC, p. 71.

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ADAMS, A., HOBERG, E.P., MCALPINE, D.F., and CLAYDEN, S. 1998. Campula oblonga (Trematode: Campulidae) from an atypical host, the thresher shark, Alopias vulpinus (Bonnaterre). J. Parasitol. 84:435-438.

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REGO, A.A., DE CHAMBRIER, A., HANZELOVA, V., HOBERG, E., SCHOLZ, T., WEEKES, P. and ZEHNDER, M. 1998. Preliminary ... analysis of sub families of the Proteocephalidea (Eucestoda). Syst. Parasitol. 40:1-19.

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HOBERG, E.P., BROOKS, D.R, MOLINA-URENA, H. and ERBE, E. 1998. Echinocephalus janzeni ... in Himantura pacifica ... from the Pacific coast ..., with ... analysis of the genus. J. Parasitol. 84:571-581.

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MIGNUCCI-GIANNONI, A.A., HOBERG, E.P., SIEGEL-CAUSEY, D., and WILLIAMS, E.H. 1998. Helminth fauna of cetaceans from the Carribean. J. Parasitol. 84:939-946.

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HOBERG, E.P. and MARIAUX, J. 1998. Phylogeny of the Eucestoda, morphological and molecular perspectives. Zool. & Botanica '98: From Gene Genealogy to Organismal History. Mus. Nat. Hist., Geneva. p. 22.

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KUTZ, S., POLLEY, L. and HOBERG, E.P. 1998. Epidemiological observations on Umingmakstrongylus pallikuukensis, ... in Arctic Canada. British Society for Parasitology Abstracts p. 38.

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KUTZ, S., HOBERG, E.P., NISHI, J. and POLLEY, L. 1998. Development of ... lungworm, ..., in the slug D. laeve, ... field conditions with comments ... climate change. Wildlife Disease Asso., Annual Conf. p. 26.

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